

2. Carbon Dioxide Emissions

Overview

U.S. Anthropogenic Carbon Dioxide Emissions, 1990-2001

	Carbon Dioxide	Carbon Equivalent
Estimated 2001 Emissions (Million Metric Tons)	5,789.0	1,578.7
Change Compared to 2000 (Million Metric Tons)	-66.6	-18.2
Change from 2000 (Percent)	-1.1%	-1.1%
Change Compared to 1990 (Million Metric Tons)	852.4	214.3
Change from 1990 (Percent)	15.7%	15.7%
Average Annual Increase, 1990-2001 (Percent)	1.3%	1.3%

Total emissions of carbon dioxide in the United States and its territories were 1,578.7 million metric tons carbon equivalent in 2001, 18.2 million metric tons carbon equivalent (1.1 percent) less than the 2000 total (Table 4). The decrease in emissions from 2000 to 2001 was the first since 1991, when a slumping economy led to a decline of 0.8 percent from 1990. The decline in carbon dioxide emissions in 2001 can be attributed in large part to a reduction in overall U.S. economic growth from 3.8 percent in 2000 to 0.3 percent in 2001; a 4.4-percent reduction in manufacturing output that lowered industrial emissions (Table 5); warmer winter weather that decreased the demand for heating fuels; and a drop in electricity demand and coal-fired power generation that reduced the growth in emissions from electricity generation. The decline in emissions from 2000 to 2001 follows an increase of 3.2 percent, or 49.7 million metric tons, from 1999 to 2000 (Figure 1). Since 1990, total U.S. carbon dioxide emissions have increased by an average of about 1.3 percent per year.

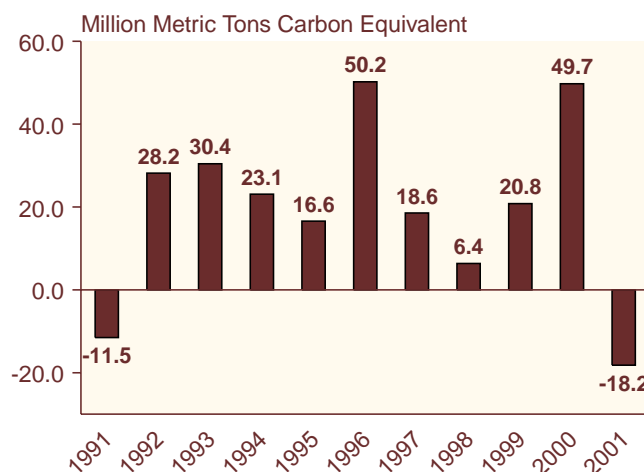
In the United States, most carbon dioxide (98 percent) is emitted as the result of the combustion of fossil fuels; consequently, carbon dioxide emissions and energy use are highly correlated. Historically, economic growth, the weather, the carbon and energy intensity of the economy, and movements in energy prices have caused

year-to-year fluctuations in energy consumption and resulting carbon dioxide emissions. Warmer-than-normal winter weather in 2001 was an important factor in reducing residential and commercial energy consumption and carbon dioxide emissions below the levels that would have been expected under normal conditions.

The decreased demand for heating fuels can be seen in the residential and commercial sectors, where energy consumption is dominated by electricity use for air conditioning during the summer and fuel use for heating during the winter. In the residential sector (Table 6), emissions of carbon dioxide declined by 1.0 percent, from 318.1 million metric tons carbon equivalent in 2000 to 314.9 million metric tons carbon equivalent in 2001. In the commercial sector (Table 7), emissions increased by 1.9 percent (from 274.4 million metric tons in 2000 to 279.7 million metric tons in 2001). Most of the economic growth in the commercial sector in 2001 was in service industries. In addition, weather conditions have a smaller effect on energy use and carbon dioxide emissions in the commercial sector than in the residential sector.

Industrial production and related energy consumption declined in 2001; the total industrial production index was down by 3.9 percent for the year. Manufacturing activity was down by 4.4 percent. The drop in the manufacturing index was the largest in recent years, even surpassing the 2.4-percent decline during the recession of

Figure 1. Annual Change in U.S. Carbon Dioxide Emissions, 1990-2001



Source: Estimates presented in this chapter.

1991. In all six of the energy-intensive industry groups, which traditionally account for about 65 to 70 percent of total industrial carbon dioxide emissions, output declined in 2001. The greatest declines were in Primary Metals (-11.4 percent), followed by Pulp and Paper (-5.1 percent) and Stone, Clay and Glass Products (-2.4 percent). Smaller declines in output were seen for the other energy-intensive industries: Food (-0.8 percent), Chemicals (-0.8 percent), and Petroleum (-0.6 percent). Preliminary results indicate that industrial emissions (Table 8) were down by 5.4 percent (from 478.4 million metric tons carbon equivalent in 2000 to 452.4 million metric tons in 2001), primarily because of the decline in industrial output.

Estimates for 2001 indicate that carbon dioxide emissions in the transportation sector (Table 9) increased by 0.8 percent, from 507.3 million metric tons carbon equivalent in 2000 to 511.6 million metric tons in 2001. The modest increase can be attributed largely to the economic slowdown late in the year that dampened demand for transportation services. Transportation sector energy demand usually is affected less by an

economic downturn than is demand for energy services in other sectors (in particular, manufacturing).

Net generation of electricity decreased by 2.2 percent from 2000 to 2001, and total carbon dioxide emissions from the electric power sector decreased by 1.5 percent, from 621.2 million metric tons carbon equivalent in 2000 to 611.7 million metric tons in 2001 (Table 10). In this report, the electric power sector is defined as all utilities, nonutilities, and combined heat and power (CHP) facilities whose primary business is the production of electric power. Carbon dioxide emissions from generators that produce electric power as part of an industrial or commercial operation—that is, businesses that produce electricity primarily for their own use—are not included in the electric power sector total but are assigned to the industrial or commercial sector according to the classification of the business. In addition, the emissions totals reported above for the energy end-use sectors (residential, commercial, industrial, and transportation) include their shares of total electric power sector emissions.⁴⁸

Evolution of EIA Emissions Estimates for the Electric Power Sector

EIA's *Emissions of Greenhouse Gases in the United States 1999*, published in October 2000, included a table that showed emissions based on electricity generation in the industrial sector and in the traditional electric power sector (electric utilities only). Emissions from the two sources were summed to provide a more complete estimate of total electric power emissions. However, in the end-use sector tables, only the electric utility emissions were shared out—as had been the case in all previous EIA emissions inventory reports. This created some confusion for readers who could not add the electricity totals across sectors and arrive at the values in the standalone table for the electric power sector.

Emissions of Greenhouse Gases in the United States 2000, published in November 2001, included a table that showed total emissions for both utility and nonutility generators in the electric power sector. Unlike the previous year, it was not a standalone table, and the emissions total was shared out to the four end-use sectors. Because none of EIA's other multi-fuel publications allocated energy consumption in quite the same way, however, the data could not be recreated by using the energy consumption data from EIA's integrated multi-fuel publications. In this and future EIA

greenhouse gas emissions inventories, estimates of electric power sector emissions will be based on data published in EIA's integrated multi-fuel publications.

The *Annual Energy Review 2001* (AER2001), published in October 2002, was the first of EIA's annual multi-fuel publications that used the revised data for electricity sector fuel consumption. In AER2001, the electric power sector data include all plants whose primary business is to sell electricity (North American Industrial Classification System—NAICS—code 22). The AER2001 consumption tables (e.g., Table 6.5 for natural gas) include the fuel used by NAICS 22 CHP plants to produce thermal energy.

In assigning emissions to end-use sectors for the greenhouse gas inventory, all the emissions related to fuel consumed for electricity-only or CHP plants remain in the commercial and industrial sector unless they are categorized as being primarily in the business of selling electricity (NAICS 22), in which case they are included in the electric power sector. The electric power sector's emissions are shared out to the end-use sectors according to the electricity consumption data in the AER2001 end-use consumption tables.

⁴⁸ As described in detail later in this chapter, the Energy Information Administration (EIA) has recently completed a reorganization of its electric power data systems to provide better accounting of fuel use, electricity generation, emissions, and other information from the U.S. electric power industry, which has undergone significant structural changes over the past decade. The data reorganization has led to revisions in EIA's historical data on fuel use for electricity generation, with corresponding revisions in the 1990-2000 estimates of energy-related carbon dioxide emissions, total greenhouse gas emissions, sector-specific emissions, and emissions by fuel type.

Nonfuel uses of fossil fuels, principally petroleum, sequestered 81.0 million metric tons carbon equivalent in 2001, down by 5.7 million metric tons (6.6 percent) from 2000 (Table 11). The major fossil fuel products that sequester carbon include liquefied petroleum gas (LPG), feedstocks for plastics and other petrochemicals, and asphalt and road oils. It is estimated that, of the amount of carbon sequestered in the form of plastic, about 6.1 million metric tons was emitted as carbon dioxide from the burning of the plastic components of municipal solid waste as well as other waste burning in 2000. The 2000 estimate of 6.1 million metric tons is used in this report as an estimate for 2001 emissions from the burning of wastes.

Emissions of carbon dioxide from other sources—including cement production, industrial processes, waste combustion, carbon dioxide in natural gas, and gas flaring—declined by 0.9 percent, from 32.0 million metric tons carbon equivalent in 2000 to 31.7 million metric tons in 2001 (Table 4). Although emissions from most sources were nearly unchanged, a decline in emissions from industrial processes resulted in a net decline for the “other sources” category.

Energy Consumption

Energy End-Use Sector Sources of U.S. Carbon Dioxide Emissions, 1990-2001

Sector	Million Metric Tons Carbon Equivalent		Percent Change	
	1990	2001	1990-2001	2000-2001
Residential	257.5	314.9	22.3%	-1.0%
Commercial	212.6	279.7	31.5%	1.9%
Industrial	458.0	452.4	-1.2%	-5.4%
Transportation	431.4	511.6	18.6%	0.8%

Note: Electric utility emissions are distributed across sectors.

The consumption of energy in the form of fossil fuel combustion is the largest single contributor to greenhouse gas emissions in the United States and the world. Of total 2001 U.S. carbon dioxide emissions (adjusting for U.S. Territories and bunker fuels), 98 percent, or 1,547.0 million metric tons carbon equivalent, resulted from the combustion of fossil fuels. This figure

represents a 1.1-percent decrease from 2000 levels. In the short term, year-to-year changes in energy consumption and carbon dioxide emissions tend to be dominated by weather, economic fluctuations, and movements in energy prices. Over longer time spans, changes in energy consumption and emissions are influenced by other factors such as population shifts and energy consumers' choice of fuels, appliances, and capital equipment (e.g., vehicles, aircraft, and industrial plant and equipment). The energy-consuming capital stock of the United States—cars and trucks, airplanes, heating and cooling plants in homes and businesses, steel mills, aluminum smelters, cement plants, and petroleum refineries—changes slowly from one year to the next, because capital stock usually is retired only when it begins to break down or becomes obsolete.

EIA divides energy consumption into four general end-use categories: residential, commercial, industrial, and transportation. Emissions from electricity generators, which provide electricity to the end-use sectors, are allocated in proportion to the electricity consumed in each sector (Table 5). Electricity-related emissions that are allocated across the end-use sectors include emissions from integrated electric utilities and emissions from nonutility power producers (including independent power producers and industrial CHP plants) whose primary business is the production and sale of electricity.

Residential Sector

At 314.9 million metric tons carbon equivalent, residential carbon dioxide emissions represented 20.2 percent of U.S. energy-related carbon dioxide emissions in 2001. The residential sector's pro-rated share of electric power sector emissions accounts for about two-thirds of that amount (216.3 million metric tons).⁴⁹ Petroleum (mainly distillate fuel oil) accounted for 8.6 percent and natural gas 22.6 percent. Since 1990, residential electricity-related emissions have grown by 2.3 percent annually. In contrast, emissions from the direct combustion of fuels, primarily natural gas, in the residential sector have grown by 0.9 percent annually since 1990.

Total carbon dioxide emissions from the residential sector decreased by 1.0 percent in 2001 (Table 6). Year-to-year, residential sector emissions are strongly influenced by weather. For example, in 1996, a relatively cold year, carbon dioxide emissions from the residential sector grew by 6.0 percent relative to 1995. In 1997, emissions declined by 0.7 percent due to warmer winter weather. The warmer winter in 2001, relative to 2000,

⁴⁹Sectoral (residential, commercial, and industrial) energy-related carbon dioxide emissions include the share of total electric power sector carbon dioxide emissions that can be attributed to each end-use sector. The share is based on the percentage of total electricity sales purchased by the sector. All carbon dioxide emissions associated with industrial or commercial enterprises whose primary business is not the production of electricity are allocated to the sectors in which they occur.

was a major contributor to the 2001 decline in residential sector emissions.

Since 1990, the growth in carbon dioxide emissions attributable to the residential sector has averaged 1.8 percent per year. Residential sector emissions in 2001 were 57.5 million metric tons carbon equivalent higher than in 1990, representing 28.9 percent of the total increase in U.S. energy-related carbon dioxide emissions since 1990. Long-term trends in residential carbon dioxide emissions are strongly influenced by demographic factors, living space attributes, and building shell and appliance efficiency choices. For example, the movement of population into the Sunbelt tends to increase summer air conditioning consumption and promote the use of electric heat pumps, which increases indirect emissions from electricity use (although the increase could be offset by a reduction in direct emissions from heating fuel combustion). Growth in the number of households, resulting from increasing population and immigration, contributes to more residential energy consumption.

Commercial Sector

Commercial sector carbon dioxide emissions, at 279.7 million metric tons carbon equivalent, account for about 17.9 percent of total energy-related carbon dioxide emissions, of which 77.0 percent (215.4 million metric tons) is the sector's pro-rated share of electricity-related emissions. Petroleum contributes 5.0 percent and natural gas 17.1 percent of the sector's emissions. Commercial sector emissions largely have their origin in the space heating and cooling requirements of structures such as office buildings. Lighting is a more important component of commercial energy demand than it is in the residential sector. Thus, although commercial sector emissions are strongly affected by the weather, they are affected less than residential sector emissions. In the longer run, because commercial activity is a factor of the larger economy, emissions from the commercial sector are more affected by economic trends and less affected by population growth than are emissions from the residential sector.

Emissions attributable to the commercial sector's pro-rated share of electricity consumption increased by 2.3 percent in 2001, while emissions from the direct combustion of fuels (dominated by natural gas, as in the residential sector) increased by 0.7 percent. Overall, carbon dioxide emissions related to commercial sector activity increased by 1.9 percent—from 274.4 to 279.7 million metric tons carbon equivalent—between 2000 and 2001 (Table 7). Since 1990, commercial emissions growth has averaged 2.5 percent per year, the largest growth of any end-use sector. Commercial sector carbon dioxide emissions have risen by 67.1 million metric tons carbon

equivalent since 1990, accounting for 33.7 percent of the total increase in U.S. energy-related carbon dioxide emissions.

Industrial Sector

Industrial sector emissions, at 452.4 million metric tons carbon equivalent, accounted for about 29 percent of total U.S. energy-related carbon dioxide emissions in 2001. In terms of fuel shares, electricity consumption was responsible for 39.6 percent of total industrial sector emissions (179.0 million metric tons), natural gas for 27.3 percent (123.4 million metric tons), petroleum for 21.6 percent (97.9 million metric tons), and coal for 11.3 percent (51.0 million metric tons).

Estimated 2001 energy-related carbon dioxide emissions in the industrial sector, at 452.4 million metric tons carbon equivalent (Table 8), were 5.4 percent lower than the 2000 emissions level of 478.4 million metric tons. Carbon dioxide emissions attributable to industrial sector energy consumption have declined by an average of 0.1 percent per year since 1990. As a result, total energy-related industrial emissions in 2001 were 1.2 percent (5.6 million metric tons) lower than in 1990, despite a much larger economy.

A contributing factor to the decline in industrial sector carbon dioxide emissions is the erosion of the older energy-intensive (and specifically coal-intensive) industrial base. For example, coke plants consumed 38.9 million short tons of coal in 1990, as compared with 26.1 million short tons in 2001. Other industrial coal consumption has declined from 76.3 million short tons in 1990 to 63.4 million short tons in 2001. Energy-intensive industries have been replaced by others that are less energy-intensive, such as computer chip and electronic component manufacturing.

Transportation Sector

Transportation sector emissions, at 511.6 million metric tons carbon equivalent, accounted for one-third of total energy-related carbon dioxide emissions in 2001. Almost all (98 percent) of transportation sector emissions result from the consumption of petroleum products: motor gasoline, at 60 percent of total transportation sector emissions; middle distillates (diesel fuel) at 21 percent; jet fuel at 13 percent of the total; and residual oil (i.e., heavy fuel oil, largely for maritime use) at 3 percent of the sector's total emissions. Motor gasoline is used primarily in automobiles and light trucks, and middle distillates are used in heavy trucks, locomotives, and ships.

Emissions attributable to the transportation sector increased by 0.8 percent in 2001, from 507.3 to 511.6 million metric tons carbon equivalent (Table 9). The

Energy-Related Carbon Dioxide Emissions in Manufacturing

Manufacturing is the single largest source of carbon dioxide emissions in the U.S. industrial sector. This industrial subsector, which excludes agriculture, mining, and construction, accounts for 85 percent of industrial energy-related carbon dioxide emissions and also accounts for approximately 84 percent of industrial energy consumption. The table below shows the latest estimates of energy-related carbon dioxide emissions from the manufacturing subsector, based on energy consumption statistics from EIA's 1998 Manufacturing Energy Consumption Survey (MECS).

Of the 405.2 million metric tons carbon equivalent emitted by manufacturers in 1998, about 43 percent (174.4 million metric tons carbon equivalent) was emitted by two industry groups: Petroleum and Coal Products (21.6 percent) and Chemicals (21.5 percent). Four other groups account for roughly 37 percent of the subsector total: Primary Metals (16.9 percent), Paper (8.0 percent), Food (6.1 percent), and Stone, Clay and Glass (5.6 percent). The Other Manufacturing group, consisting of 14 industries that range from apparel to fabricated metals to computer manufacturing, accounts for the remaining 20 percent; none of those 14 industry groups separately accounts for more than 3 percent of total energy-related carbon dioxide emissions from the manufacturing subsector.

The mix and quantity of manufacturers' demand for fuel and nonfuel uses of energy affects the subsector's carbon intensity of energy use—i.e., the ratio of carbon emitted per unit of energy used (see box in Chapter 1, page 14). Overall, manufacturing industries had carbon intensities of 12.67 and 12.17 million metric tons carbon equivalent per quadrillion Btu in 1991 and 1998,

respectively; however, the carbon intensities of the various industry groups differed markedly.

Both the petroleum industry and the chemical industry transform energy sources into products, such as petrochemical feedstocks, asphalt, and plastics. Only a part of the carbon content of energy inputs is emitted to the atmosphere; the remainder is sequestered in the products (see Table A2 in Appendix A).^a Because both the petroleum and chemical industries use energy for nonfuel purposes, both have lower carbon intensities than the manufacturing average: 12.14 and 11.35 million metric tons carbon equivalent per quadrillion Btu for the petroleum industry in 1991 and 1998, respectively; and 11.61 and 11.15 million metric tons carbon equivalent per quadrillion Btu for the chemicals industry.

The paper industry uses wood byproducts extensively, yielding carbon intensities of 9.55 and 9.17 million metric tons carbon equivalent per quadrillion Btu in 1991 and 1998, respectively. Carbon dioxide emissions from wood consumption are considered to be zero, because the carbon emitted has been recently sequestered and the regrowing of trees will re-sequester the emitted carbon. The primary metals industry, however, is a heavy user of energy sources with high carbon content, such as coal. As a result, the overall carbon intensity for the primary metals industry was 16.12 million metric tons carbon equivalent per quadrillion Btu in 1991 and 16.11 in 1998.

The 1991 MECS estimated consumption that yielded carbon dioxide emissions from the manufacturing
(continued on page 24)

Carbon Dioxide Emissions from Manufacturing by Industry Group, 1998

Industry Group	SIC Code	Carbon Dioxide Emissions (Million Metric Tons Carbon Equivalent)	Share of Total Manufacturing Emissions (Percent)	Carbon Intensity of Energy Use (Million Metric Tons Carbon Equivalent per Quadrillion Btu Consumed)
Petroleum . . .	29	87.4	21.6	11.35
Chemicals . . .	28	87.1	21.5	11.15
Metals	33	68.4	16.9	16.11
Paper	26	32.3	8.0	9.17
Food	20	24.6	6.1	13.58
Glass	32	22.6	5.6	16.32
Other Manufacturing . . .		82.8	20.4	12.15
Total		405.2	100.0	12.17

Sources: Energy Information Administration, Form EIA-846, "Manufacturing Energy Consumption Survey," and Form EIA-810, "Monthly Refinery Report" (1998).

^aAppendixes for this report are available on web site www.eia.doe.gov/oiaf/1605/ggrrpt/index.html.

fuel-use patterns and related emissions sources in the transportation sector are different from those in the other end-use sectors. By far the largest single source of emissions, motor gasoline, at 308.0 million metric tons carbon equivalent, grew by 2.1 percent. Since 1990, carbon dioxide emissions related to the transportation sector have increased at an average annual rate of 1.6 percent. The growth since 1990 has meant that transportation emissions have increased by a total of 80.2 million metric tons, representing 40.3 percent of the growth in energy-related carbon dioxide emissions from all sectors. Transportation is the largest contributing sector to total emissions.

Electric Power Sector

The data in Table 10 represent estimates of carbon dioxide emissions for the electric power sector. These emissions when taken as a whole account for 39.2 percent of total U.S. energy-related carbon dioxide emissions. The electric power sector includes traditional regulated utilities, as well as independent power producers whose primary business is the generation and sale of electricity. The industrial sector and, to a much lesser extent, the commercial sector also include establishments that generate electricity; however, their primary business is not electricity generation, and so their electricity-related

Electric Power Sector Carbon Dioxide Emissions by Fuel Input, 1990-2001

Fuel	Million Metric Tons Carbon Equivalent		Percent Change	
	1990	2001	1990-2001	2000-2001
Petroleum	27.0	27.5	1.7%	11.9%
Natural Gas	47.8	77.7	62.5%	1.5%
Coal	417.3	506.4	21.3%	-2.6%
Total	492.3	611.7	24.3%	-1.5%

emissions are included in the totals for those sectors, not in the electric power sector.

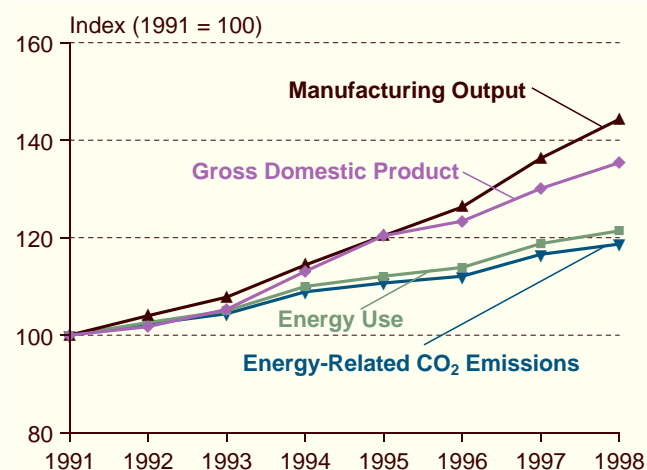
Preliminary estimates indicate that carbon dioxide emissions from the electric power sector decreased by 1.5 percent (9.6 million metric tons carbon equivalent), from 621.2 million metric tons in 2000 to 611.7 million metric tons in 2001 (Table 10). Emissions from natural-gas-fired generation increased by 1.5 percent, emissions from coal-fired generation decreased by 2.6 percent, and emissions from petroleum-fired generation increased by

Energy-Related Carbon Dioxide Emissions in Manufacturing (Continued)

subsector as a whole totaling 341.3 million metric tons carbon equivalent. The corresponding estimate for 1998 is 405.2 million metric tons—an increase of 63.9 million metric tons or 18.7 percent. Over the same interval, manufacturing output increased by 44.3 percent, and gross domestic product (GDP) increased by 35.4 percent (in constant 1996 dollars). Thus, the MECS data suggest more efficiency in manufacturing energy consumption relative to output, with production increasing on average by 5.4 percent per year and energy consumption by only 3.1 percent per year from 1991 to 1998 (see figure). As a result, manufacturing output was more than 40 percent higher in 1998 than in 1991, but energy-related carbon dioxide emissions were only 20 percent higher.

From 1994 to 1998, carbon dioxide emissions associated with electricity use by manufacturing industries increased by 22.1 million metric tons carbon equivalent (17 percent), and emissions associated with natural gas use increased by 8.7 million metric tons carbon equivalent (9 percent). Electricity use continues to account for the largest share of manufacturers' carbon dioxide emissions—35 percent (131.1 million metric tons) and 38 percent (153.2 million metric tons) in 1994 and 1998, respectively (see table on page 25). Smaller changes,

Energy and Emissions Trends in the U.S. Manufacturing Sector, 1991-1998



Source: Energy Information Administration, Federal Reserve Board, and Bureau of Economic Analysis. Values for 1992, 1993, 1995, 1996, and 1997 are interpolated.

which are not statistically significant, are estimated for emissions associated with manufacturing use of coal (a slight decrease) and petroleum and other fuels (a slight increase).

(continued on page 25)

Energy-Related Carbon Dioxide Emissions in Manufacturing (Continued)

Carbon Dioxide Emissions from Manufacturing by Fuel, 1991, 1994, and 1998

Fuel Type	SIC Code						Other Mfg.	Total
	29	28	33	26	20	32		
1991								
CO ₂ Emissions (Million Metric Tons Carbon Equivalent)								
Petroleum	40.9	11.5	0.9	3.7	1.0	1.7	2.8	62.6
Natural Gas	12.1	27.9	10.2	7.9	7.4	5.5	12.6	83.6
Coal	0.4	6.9	22.7	7.7	3.9	7.6	3.5	52.7
Electricity	5.4	22.7	25.7	10.4	8.7	5.4	43.9	122.1
Other	16.6	2.6	0.8	0.1	0.0	0.0	0.1	20.3
Total	75.4	71.6	60.4	29.8	21.0	20.3	63.0	341.3
Share of Total Manufacturing Energy Use (Percent)	23.0	22.9	13.9	11.6	5.5	4.5	18.7	100.0
Share of Total Manufacturing CO ₂ Emissions (Percent)	22.1	21.0	17.7	8.7	6.2	5.9	18.4	100.0
Carbon Intensity of Energy Use (Million Metric Tons Carbon Equivalent per Quadrillion Btu Consumed) .	12.14	11.61	16.12	9.55	14.26	16.87	12.51	12.67
1994								
CO ₂ Emissions (Million Metric Tons Carbon Equivalent)								
Petroleum	47.7	11.5	1.3	4.3	1.2	2.0	2.7	70.7
Natural Gas	11.7	32.1	11.7	8.3	9.1	6.2	14.5	93.5
Coal	0.0	7.8	26.2	7.8	4.3	7.2	3.5	56.8
Electricity	6.0	25.7	24.3	11.0	9.8	6.1	48.3	131.1
Other	16.5	1.2	0.9	0.3	0.1	0.1	0.4	19.6
Total	81.8	78.3	64.5	31.6	24.4	21.6	69.4	371.7
Share of Total Manufacturing Energy Use (Percent)	22.6	23.2	13.3	11.2	6.0	4.4	19.2	100.0
Share of Total Manufacturing CO ₂ Emissions (Percent)	22.0	21.1	17.4	8.5	6.6	5.8	18.7	100.0
Carbon Intensity of Energy Use (Million Metric Tons Carbon Equivalent per Quadrillion Btu Consumed) .	12.21	11.35	16.32	9.48	13.61	16.39	12.21	12.52
1998								
CO ₂ Emissions (Million Metric Tons Carbon Equivalent)								
Petroleum	47.7	15.4	1.0	4.1	0.8	1.8	2.8	73.7
Natural Gas	14.5	34.8	13.1	8.5	8.7	6.4	16.3	102.2
Coal	0.0	7.3	25.7	7.0	3.7	7.6	2.7	54.1
Electricity	6.2	28.2	27.8	12.4	11.4	6.6	60.5	153.2
Other	19.0	1.3	0.9	0.2	0.0	0.2	0.4	22.1
Total	87.4	87.1	68.4	32.3	24.6	22.6	82.8	405.2
Share of Total Manufacturing Energy Use (Percent)	23.1	23.4	12.8	10.6	5.5	4.2	20.5	100.0
Share of Total Manufacturing CO ₂ Emissions (Percent)	21.6	21.5	16.9	8.0	6.1	5.6	20.4	100.0
Carbon Intensity of Energy Use (Million Metric Tons Carbon Equivalent per Quadrillion Btu Consumed) .	11.35	11.15	16.11	9.17	13.58	16.32	12.15	12.17

Note: To calculate carbon intensity and percent of Btu, electricity was calculated as primary electricity: 10,436 Btu per kilowatthour for 1991, 10,316 for 1994, and 10,346 for 1998. These conversion factors represent the average energy input to the generation process for fossil-fired utility plants in the United States. See Energy Information Administration, *Monthly Energy Review*, DOE/EIA-0035(2002/09) (Washington, DC, September 2002), Table A6.

Sources: Energy Information Administration, Form EIA-846, "Manufacturing Energy Consumption Survey," and Form EIA-810, "Monthly Refinery Report" (1991, 1994, and 1998).

11.9 percent. Carbon dioxide emissions from the electric power industry have grown by 24.3 percent since 1990, while total carbon dioxide emissions have grown by 14.6 percent. The 2001 decrease can be attributed largely to a 2.2-percent drop in total electricity generation and a 2.6-percent decline in emissions from coal-fired power plants, which are the predominant and most carbon-intensive source of power generation. Contributing to the overall decline in emissions from the electric power sector in 2001 was a 2.0-percent increase in generation from nuclear fuel, which produces no carbon dioxide emissions.

EIA has recently completed a reorganization of its electricity data to reflect the changes in ownership and generation patterns that have taken place in the electric power sector since the early 1990s. This report makes use of those data. Carbon dioxide emissions from nonutility power producers, including independent power producers that produce only electricity, as well as those combined heat and power (CHP) producers (also known as cogenerators) whose primary business is the production of electricity, are included with carbon dioxide emissions from traditional electric utilities in the electric power sector (Table 10). Carbon dioxide emissions from CHP producers that generate electricity primarily for their own use are included in industrial or commercial sector carbon dioxide emissions, depending on the classification of each producer's primary business. Thus, the electricity-related emissions that are shared out to the end-use sectors are based only on purchased electricity from the electric power sector. The box on page 27 describes the changes that have been made in EIA's electricity data systems and their effects on the EIA estimates of carbon dioxide emissions related to energy consumption.

Nonfuel Use of Energy Inputs

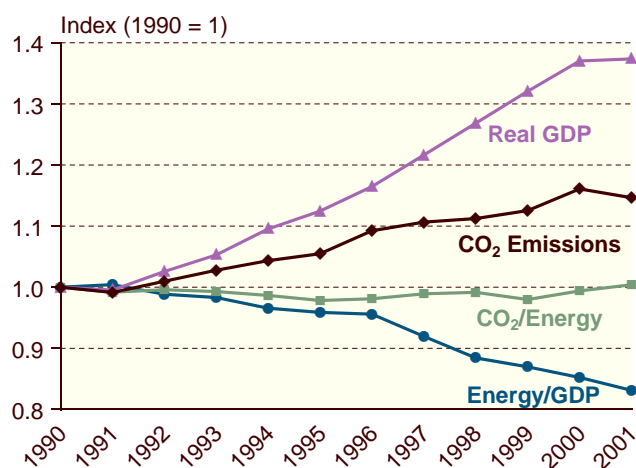
In 2001, 81.0 million metric tons carbon equivalent was sequestered through nonfuel uses of fossil fuels (Table 11). The vast majority of this sequestered carbon was in petroleum-based products (75.9 million metric tons), with smaller amounts in natural-gas-based products (4.6 million metric tons) and coal-based products (less than 0.5 million metric tons carbon equivalent). The main products that sequester carbon include feedstocks for plastics and other petrochemicals, asphalt and road oil, liquefied petroleum gas, lubricants, and waxes. The amount sequestered in 2001 was 6.6 percent lower than in 2000, when 86.7 million metric tons carbon equivalent was sequestered. Since 1990, the annual sequestration of carbon in this manner has increased by 12.3 million metric tons or 18.0 percent. This translates to an average annual growth rate of 1.5 percent.

Carbon Dioxide Emissions and Economic Growth

Between 1990 and 2001, U.S. economic growth averaged 2.9 percent per year. Energy-related carbon dioxide emissions, however, grew by an average of 1.3 percent annually. As shown in Figure 2, U.S. energy intensity (energy consumed per dollar of GDP) fell by an average of 1.7 percent per year from 1990 to 2001. The carbon dioxide intensity of energy use (carbon-equivalent emissions per unit of energy consumed) has remained roughly at the 1990 level. Thus, it is the use of less energy per unit of economic output, not the use of low-carbon fuels, that has kept the growth rate of carbon dioxide emissions equal to about half the growth rate of GDP.

The decrease in the energy intensity of the U.S. economy has resulted, in part, from an increase in the non-energy-intensive sectors of the economy relative to the traditional energy-intensive manufacturing industries, as well as energy efficiency improvements. Economic growth does, however, have an indirect effect on emissions, in that consumers with more disposable income use more energy services (such as travel) and tend to live in larger houses. On the other hand, such income effects can be offset somewhat by more energy-efficient vehicles, building shells, appliances, and heating and cooling equipment. It is expected that the trend of increasing energy efficiency will continue in the future, further reducing the carbon intensity of the U.S. economy.

Figure 2. Growth in U.S. Carbon Dioxide Emissions and GDP, Energy Intensity of GDP, and Carbon Dioxide Intensity of Energy Use, 1990-2001



Sources: Energy Information Administration, *Annual Energy Review 2001*, DOE/EIA-0384(2001) (Washington, DC, July 2001), Tables 1.1 and E1; and estimates presented in this chapter.

EIA Changes to Electric Power Sector and Fossil Fuel Data

EIA has comprehensively reviewed and revised how it collects, estimates, and reports fuel use for facilities producing electricity. The review addressed both inconsistent reporting of the fuels used for electric power across historical years and changes in the electric power marketplace that have been inconsistently represented in various EIA survey forms and publications.

The goal of EIA's comprehensive review was to improve the quality and consistency of its electric power data throughout all data and analysis products. Because power facilities operate in all sectors of the economy (e.g., in commercial buildings, such as hospitals and college campuses, and industrial facilities, such as paper mills and refineries) and use many fuels, any change to electric power data affects data series in nearly all fuel areas and causes changes in a wide variety of EIA publications.

As a result of the comprehensive review, the following changes have been made:

- EIA has adjusted all presentations of data on electric power to a consistent format and defined the electric power sector to include electricity-only and CHP plants^a whose primary business is to sell electricity, or electricity and heat, to the public.
- EIA is providing detail on fuel used by CHP plants in the electric power, commercial, and industrial sectors.
- EIA has changed the source of data on fuel used by components of the electric power sector: all tabulations and publications will use data obtained from EIA's surveys of electric power generators. This change in data source affects the reporting of EIA's historical data for total fuel consumption of natural gas. The revisions contribute to changes in EIA's electricity series as well as the fuel-use series.

As a result of these changes, EIA has revised its estimates for the years 1990 through 2000 for energy-related carbon dioxide emissions, total greenhouse gas emissions, sector-specific emissions, and emissions by fuel type. EIA's *Annual Energy Review 2001 (AER2001)* was the first of its annual reports in which the revised electricity and fuel data were

published. The emissions reported in this publication are based largely on the data published in *AER2001*.

Summary of Changes in Greenhouse Gas Emissions Estimates

This report assigns all energy-consumption-related carbon dioxide emissions to one of four end-use sectors: residential, commercial, industrial, and transportation. A sector's emissions consist of the fuels directly burned in that sector (e.g., natural gas consumed to heat homes), as well as the sector's share of emissions resulting from electricity generation, based on its market share of purchased electricity. Emissions attributable to the electric power sector (which includes entities other than utilities) are shared out to the end-use sectors. The electric power sector includes electricity-only plants (utilities and independent power producers) and CHP plants that are primarily in the business of selling electricity.

In EIA's earlier emissions inventories (1990-1999), only emissions attributable to conventional electric utilities were shared out to the end-use sectors (see box on page 20); all emissions from nonutility generators were assigned to the industrial sector, even though some of those emissions were associated with electricity sold into the electricity grid and consumed in the residential and commercial sectors. In last year's inventory report (for data year 2000), nonutility emissions were reallocated to the energy end-use sectors.^b For this year's inventory, the allocation of electricity sector emissions to the end-use sectors is based on energy data presented in EIA's multi-fuel publications and is not unique to this report.

Changes to Fossil Fuel Inputs

In addition to changes in data for the electric power sector, the review of EIA data resulted in changes to primary fossil fuel inputs that affect both the sectoral allocation of those fuels and total energy consumption and therefore affect the estimates of total energy-related carbon dioxide emissions. The changes principally affect the natural gas data series, but there are also smaller changes in historical data for the other fossil fuels. As a result, this report includes revised
(continued on page 28)

^aCombined heat and power (CHP) plants produce both electricity and useful thermal output. EIA formerly referred to these plants as cogenerators, but has determined that CHP better describes the facilities because some of the plants included in EIA's data do not produce heat and power in a sequential fashion, and as a result do not meet the legal definition of cogeneration specified in the Public Utilities Regulatory Policy Act (PURPA).

^bThe method used for the reallocation is described in Energy Information Administration, *Emissions of Greenhouse Gases in the United States 2000*, DOE/EIA-0573(2000) (Washington, DC, November 2001), p. 20.

EIA Changes to Electric Power Sector and Fossil Fuel Data (Continued)

1990-2000 estimates for carbon dioxide emissions by sector (see table below) and by fuel (see table on page 29).

Natural Gas Consumption

In past EIA data publications, natural gas consumption was presented for the residential, commercial, industrial, transportation, and electric utility sectors. Deliveries of natural gas to independent power producers (called "other nonutility power producers" on EIA survey forms) were included in the data reported for the industrial sector, and the measures were collected through natural gas survey forms submitted by gas delivery agents (local distribution companies and pipelines).

As with the other data, beginning with *AER2001*, the definition of industrial sector gas consumption for 1993-2001 no longer includes independent power producers. The new definition of the electric power sector includes independent power producers, utilities, and other electricity generators whose primary business is

selling electricity. The data reported for the electric power sector are derived entirely from data submitted on EIA's electricity data collection forms, including Forms EIA-759, "Monthly Power Plant Report," and EIA-860B, "Annual Electric Generator Report—Non-utility," through 2000 and Form EIA-906, "Power Plant Report," for 2001.

In comparison with past energy data publications, the impact of the definitional change for the industrial sector is to reduce measured natural gas consumption in the sector. For example, in *AER2000* EIA showed 9.39 trillion cubic feet delivered to industrial facilities in 2000. In *AER2001*, the comparable figure (under the "other industrial" heading) for 2000 is 8.25 trillion cubic feet. However, total estimated carbon dioxide emissions in the industrial sector are higher because last year's report reallocated all electricity-related emissions from the industrial sector to the electric power sector (see box on page 20). This year's report is based on data that include energy for companies whose primary business is the production of electricity

(continued on page 29)

Revisions to EIA Estimates of U.S. Carbon Dioxide Emissions from Energy Consumption by End-Use Sector, 1990-2000

(Million Metric Tons Carbon Equivalent)

End-Use Sector	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
CO₂ Emissions Estimates, This Report											
Residential	257.5	263.0	263.0	279.6	277.2	280.1	297.0	295.0	297.6	302.5	318.1
Commercial	212.6	213.2	213.4	220.0	223.4	228.5	237.4	249.3	253.9	258.0	274.4
Industrial	458.0	447.6	465.6	461.7	469.2	468.0	482.2	486.9	479.5	474.2	478.4
Transportation	431.4	424.1	430.8	436.1	448.9	457.4	468.5	473.2	481.3	495.3	507.3
Total	1,359.5	1,347.8	1,372.8	1,397.3	1,418.7	1,434.1	1,485.2	1,504.3	1,512.3	1,530.1	1,578.3
Electric Power	492.3	492.2	495.7	515.9	522.5	526.8	546.5	564.8	589.2	592.8	621.2
<i>Electric Power Percent of Total . .</i>	<i>36.2%</i>	<i>36.5%</i>	<i>36.1%</i>	<i>36.9%</i>	<i>36.8%</i>	<i>36.7%</i>	<i>36.8%</i>	<i>37.5%</i>	<i>39.0%</i>	<i>38.7%</i>	<i>39.4%</i>
CO₂ Emissions Estimates, Last Year's Report											
Residential	257.0	261.6	261.8	278.4	275.8	277.9	293.9	292.8	293.7	298.8	313.4
Commercial	210.3	210.4	210.8	217.2	220.4	224.6	233.1	245.4	250.4	253.1	267.8
Industrial	452.7	439.8	455.1	452.9	463.3	461.1	476.1	481.5	469.5	465.8	465.7
Transportation	431.8	424.2	431.1	436.4	449.3	457.8	468.9	473.6	481.5	499.4	514.8
Total	1,351.7	1,336.0	1,358.7	1,384.8	1,408.8	1,421.3	1,471.9	1,493.3	1,495.2	1,517.1	1,561.7
Electric Power	507.0	506.0	512.0	532.4	540.7	542.5	562.1	583.1	607.2	612.6	641.6
<i>Electric Power Percent of Total . .</i>	<i>37.5%</i>	<i>37.9%</i>	<i>37.7%</i>	<i>38.4%</i>	<i>38.4%</i>	<i>38.2%</i>	<i>38.2%</i>	<i>39.0%</i>	<i>40.6%</i>	<i>40.4%</i>	<i>41.1%</i>
Changes from Last Year's Report to This Report											
Residential	0.4	1.3	1.2	1.3	1.4	2.3	3.1	2.2	3.9	3.7	4.7
Commercial	2.4	2.8	2.6	2.7	3.0	3.9	4.3	3.9	3.5	5.0	6.6
Industrial	5.4	7.8	10.5	8.8	6.0	7.0	6.1	5.4	10.0	8.5	12.7
Transportation	-0.4	-0.2	-0.3	-0.3	-0.4	-0.4	-0.3	-0.5	-0.3	-4.1	-7.5
Total	7.8	11.8	14.1	12.5	9.9	12.8	13.3	11.0	17.1	13.0	16.6
Electric Power	-14.7	-13.8	-16.3	-16.6	-18.2	-15.7	-15.6	-18.3	-18.0	-19.8	-20.4
<i>Electric Power Percent of Total . .</i>	<i>-1.3</i>	<i>-1.4</i>	<i>-1.6</i>	<i>-1.5</i>	<i>-1.5</i>	<i>-1.4</i>	<i>-1.4</i>	<i>-1.5</i>	<i>-1.7</i>	<i>-1.6</i>	<i>-1.7</i>

Sources: Energy Information Administration, *Emissions of Greenhouse Gases in the United States 2000*, DOE/EIA-0573(2000) (Washington, DC, November 2001), and estimates presented in this chapter.

EIA Changes to Electric Power Sector and Fossil Fuel Data (Continued)

in the electric power sector. Energy consumption and related emissions from other industrial electricity producers are included in the industrial sector, even if some of that electricity is sold to other sectors. This change is a result of the change in the operational definition of deliveries to the industrial sector.

In comparison with past publications, the impact of the definitional change and the new data sources for the electric power sector is to increase measured natural gas consumption. As a result of the changes in data sources (predominantly new electric power data sources), total natural gas consumption is higher than previously published. Total natural gas consumption in the electric power sector for 1998, 1999, and 2000 has been revised upward by 5 percent, 3 percent, and 3 percent, respectively.

Also beginning with the publication of *AER2001* and following with the *Natural Gas Annual*, new detail is available about natural gas consumption in the commercial, industrial, and electric power sectors that distinguishes deliveries of natural gas to CHP plants from deliveries to other facilities. "Deliveries to industrial consumers" includes deliveries to industrial consumers that are CHP plants (such as those at paper mills) and to other industrial users. Included with the CHP

plant data are a small number of industrial firms that report using natural gas only to generate electricity (most likely for their own use). "Deliveries to commercial consumers" also include deliveries to CHP plants, such as those at hospitals. Similarly, a small number of plants that report natural gas use only for electricity generation are included with the data on commercial CHP plants. The sources for total commercial and industrial sector data are natural gas survey forms, and the sources for the subcomponent CHP data series are electric power survey forms. The sources of all electric power data series, including the CHP subcomponent, are electric power survey forms.

As shown in the table below, when adjusted for nonfuel uses, estimated carbon dioxide emissions from natural gas for 1990-2000 are higher than the estimates in last year's report. In percentage terms, the increase ranges from 2.4 percent (6.4 million metric tons carbon equivalent) in 1990 to 4.4 percent (13.6 million metric tons) in 1998.

Petroleum and Coal Emissions

There were also some changes to coal emissions and to a lesser extent petroleum. The changes to petroleum
(continued on page 30)

Revisions to EIA Estimates of U.S. Carbon Dioxide Emissions from Energy Consumption by Fuel, 1990-2000

(Million Metric Tons Carbon Equivalent)

Fuel	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
CO₂ Emissions Estimates, This Report											
Petroleum	590.5	576.2	586.9	588.3	600.9	597.0	619.4	625.3	635.6	650.3	658.8
Coal	489.3	485.6	489.5	505.6	508.5	514.0	536.7	548.4	552.6	553.7	578.7
Natural Gas	279.7	285.9	296.3	303.3	309.2	323.0	329.0	330.5	324.0	325.9	340.7
Total Fossil Fuels	1,359.4	1,347.7	1,372.7	1,397.2	1,418.6	1,434.0	1,485.1	1,504.2	1,512.2	1,530.0	1,578.2
CO₂ Emissions Estimates, Last Year's Report											
Petroleum	590.4	576.1	586.6	587.7	600.3	596.3	618.7	624.6	634.4	649.3	657.7
Coal	487.9	482.0	486.0	501.9	507.1	510.3	532.6	547.4	550.4	552.6	572.8
Natural Gas	273.2	278.1	286.3	295.5	301.5	314.5	320.4	321.5	310.5	315.3	331.2
Total Fossil Fuels	1,351.6	1,336.1	1,358.9	1,385.0	1,408.9	1,421.1	1,471.7	1,493.4	1,495.4	1,517.2	1,561.7
Changes from Last Year's Report to This Report											
Petroleum	0.1	0.1	0.2	0.6	0.6	0.7	0.7	0.7	1.2	1.0	1.0
Coal	1.3	3.6	3.5	3.8	1.4	3.6	4.1	1.1	2.1	1.2	5.9
Natural Gas	6.4	7.8	10.0	7.8	7.7	8.5	8.6	9.0	13.6	10.6	9.5
Total Fossil Fuels	7.8	11.6	13.7	12.2	9.7	12.9	13.4	10.8	16.9	12.8	16.5
Percentage Changes from Last Year's Report to This Report											
Petroleum	0.0%	0.0%	0.0%	0.1%	0.1%	0.1%	0.1%	0.1%	0.2%	0.2%	0.2%
Coal	0.3%	0.8%	0.7%	0.8%	0.3%	0.7%	0.8%	0.2%	0.4%	0.2%	1.0%
Natural Gas	2.4%	2.8%	3.5%	2.7%	2.5%	2.7%	2.7%	2.8%	4.4%	3.3%	2.9%
Total Fossil Fuels	0.6%	0.9%	1.0%	0.9%	0.7%	0.9%	0.9%	0.7%	1.1%	0.8%	1.1%

Sources: Energy Information Administration, *Emissions of Greenhouse Gases in the United States 2000*, DOE/EIA-0573(2000) (Washington, DC, November 2001), and estimates presented in this chapter.

EIA Changes to Electric Power Sector and Fossil Fuel Data (Continued)

are all 0.2 percent or less and can be attributed to slight differences in the details of the data series used last year (the *Monthly Energy Review*) and this year (the *Annual Energy Review*). The coal data contain some data revisions (for example, for 2000). Also, the change in categories—for example, moving coal consumption

from the industrial to the electric power sector—entails applying different carbon coefficients that can make the change in emissions differ from the change in underlying consumption values. The changes to coal emissions were all 1 percent or less.

(carbon-equivalent emissions of greenhouse gases per unit of GDP) at an average rate of 1.5 percent per year through 2020.⁵⁰

Adjustments to Energy Consumption

Total energy consumption and the carbon dioxide emissions upon which they are based correspond to EIA's coverage of energy consumption, which includes the 50 States and the District of Columbia. Under the United Nations Framework Convention on Climate Change (UNFCCC), however, the United States is also responsible for counting emissions emanating from its territories, and their emissions are added to the U.S. total. Conversely, because the Intergovernmental Panel on Climate Change (IPCC) definition of energy consumption excludes international bunker fuels from the statistics of all countries, emissions from international bunker fuels are subtracted from the U.S. total. Additionally, military bunker fuels are subtracted because they are also excluded by the IPCC from the national total. These sources and subtractions are enumerated and described as "adjustments to energy."

U.S. Territories

Energy-related carbon dioxide emissions for the U.S. territories are added as an adjustment in keeping with IPCC guidelines for national emissions inventories. The territories included are Puerto Rico, the U.S. Virgin Islands, American Samoa, Guam, the U.S. Pacific Islands, and Wake Island. Most of these emissions are from petroleum products; however, Puerto Rico and the Virgin Islands consume coal in addition to petroleum products. For 2001, total energy-related carbon dioxide emissions from the U.S. Territories are estimated at 14.8 million metric tons carbon equivalent (Table 4).

International Bunker Fuels

In keeping with the IPCC guidelines for estimating national greenhouse gas emissions, carbon dioxide emissions from international bunker fuels are subtracted from the estimate of total U.S. energy-related emissions of carbon dioxide. The estimate for bunker fuels is based on purchases of distillate and residual fuels by foreign-bound ships at U.S. seaports, as well as jet fuel purchases by international air carriers at U.S. airports. Additionally, U.S. military operations for which fuel was originally purchased in the United States but consumed in international waters or airspace are subtracted from the total, because they are also considered international bunker fuels under this definition.

For 2001, the carbon dioxide emissions estimate for military bunker fuels is 2.2 million metric tons carbon equivalent (3.5 percent higher than 2000).⁵¹ In 2001, approximately 26.5 million metric tons was emitted in total from international bunker fuels, including 24.2 million metric tons attributed to civilian consumption of bunker fuels. The total amount is subtracted from the U.S. total in Table 4. Just over half of the carbon dioxide emissions associated with international bunker fuels are from the combustion of jet fuels; residual and distillate fuels account for the other half, with most coming from residual fuel.

Other Carbon Dioxide Emissions

Energy Production

In addition to emissions resulting from fossil energy consumed, oil and gas production leads to emissions of carbon dioxide from sources other than the combustion of those marketed fossil fuels. The two energy production sources estimated for this report are:

⁵⁰Energy Information Administration, *Annual Energy Outlook 2003*, DOE/EIA-0383(2003) (Washington, DC, January 2003).

⁵¹Based on early estimates from the U.S. Department of Defense (DoD). The new DoD estimates include adjustments to past values. For example, the 1990 estimate has been revised from 4.9 to 3.7 million metric tons carbon equivalent, and the 1999 estimate has been revised from 2.7 to 2.1 million metric tons (last year's report used 1999 as a proxy for 2000). Final numbers will be published by the U.S. Environmental Protection Agency in April 2003.

U.S. Carbon Dioxide Emissions from Other Sources, 1990-2001

Estimated 2001 Emissions (Million Metric Tons Carbon Equivalent)	31.7
Change Compared to 2000 (Million Metric Tons Carbon Equivalent)	-0.3
Change from 2000 (Percent)	-0.9%
Change Compared to 1990 (Million Metric Tons Carbon Equivalent)	4.2
Change from 1990 (Percent)	15.5%

- Flared natural gas (gas burned at the production site), which is flared either because the cost of bringing the gas to market is prohibitive or because the gas is of insufficient quality to sell
- Carbon dioxide scrubbed from natural gas to improve its heat content and quality and subsequently vented to the atmosphere.

Because many States require flaring of natural gas, EIA assumes that all gas reported under the category "Vented and Flared" is actually flared and therefore should be counted as carbon dioxide emissions rather than methane emissions. In 2001, about 1.7 million metric tons carbon equivalent was emitted in this way (Table 4).

By computing the difference between the estimated carbon dioxide content of raw gas and the carbon dioxide content of pipeline gas, the amount of carbon dioxide that has been removed (scrubbed) in order to improve the heat content and quality of natural gas can be calculated. This amount was about 5.0 million metric tons carbon equivalent in 2001 (Table 4). Appendix D contains data on additional energy production sources that are excluded from this report.

Industrial Process Emissions

Industrial emissions of carbon dioxide not caused by the combustion of fossil fuels accounted for only 1.2 percent (18.8 million metric tons carbon equivalent) of total U.S. carbon dioxide emissions in 2001 (Table 4). Process-related emissions from industrial sources depend largely on the level of activity in the construction industries and on production at oil and gas wells. These sources include limestone and dolomite calcination,

soda ash manufacture and consumption, carbon dioxide manufacture, cement manufacture, and aluminum production.

Estimated industrial process emissions of carbon dioxide in 2001 were 2.4 million metric tons carbon equivalent (14.9 percent) higher than in 1990 and 0.5 million metric tons (2.6 percent) lower than in 2000 (Table 12). Sixty percent of the carbon dioxide emissions from industrial processes are from cement manufacture. When calcium carbonate is heated (calcined) in a kiln, it is converted to lime and carbon dioxide. The lime is combined with other materials to produce clinker (an intermediate product from which cement is made), and the carbon dioxide is released to the atmosphere. In 2001, the United States manufactured an estimated 89.6 million metric tons of cement, resulting in the direct release of carbon dioxide containing 11.4 million metric tons carbon equivalent into the atmosphere. This calculation is independent of the carbon dioxide released by the production of energy consumed in making cement. This represents an increase in carbon dioxide emissions of 2.3 million metric tons carbon equivalent (25.0 percent) compared with 1990 and an increase of about 0.1 million metric tons (0.9 percent) compared with 2000.

There are numerous other industrial processes in which carbonate minerals are used in ways that release carbon dioxide into the atmosphere, including the use of limestone in the production of lime and in flue gas desulfurization and the manufacture and some uses of soda ash. Carbon dioxide is also released during aluminum smelting, when carbon anodes (with the carbon derived from nonfuel use of fossil fuels) are vaporized in the presence of aluminum oxide. Approximately 7.4 million metric tons carbon equivalent was released in emissions from these other industrial process sources in 2001.

Municipal solid waste that is combusted contains, on average, a portion that is composed of plastics, synthetic rubber, synthetic fibers, and carbon black. The carbon in these plastics has normally been accounted for as sequestered carbon, as reported in Table 11. However, according to the IPCC, to properly account for that carbon, emissions from the plastics portion of the municipal solid waste must be counted in total national emissions inventories. These emissions produce about 6.1 million metric tons carbon equivalent, as calculated by the U.S. EPA, with the most recent estimate being for 2000. The 2000 value has been used as an estimate for 2001.

Carbon Dioxide Emissions

Table 4. U.S. Carbon Dioxide Emissions from Energy and Industry, 1990-2001
(Million Metric Tons Carbon Equivalent)

Fuel Type or Process	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	P2001
Energy Consumption												
Petroleum	590.5	576.2	586.9	588.3	600.9	597.0	619.4	625.3	635.6	650.3	658.8	668.0
Coal	489.3	485.6	489.5	505.6	508.5	514.0	536.7	548.4	552.6	553.7	578.7	561.1
Natural Gas	279.7	285.9	296.3	303.3	309.2	323.0	329.0	330.5	324.0	325.9	340.7	329.4
Geothermal	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Energy Subtotal	1,359.5	1,347.8	1,372.8	1,397.3	1,418.7	1,434.1	1,485.2	1,504.3	1,512.3	1,530.1	1,578.3	1,558.7
Adjustments to Energy												
U.S. Territories (+)	8.4	9.7	9.7	10.8	10.9	11.4	10.2	10.9	13.0	13.6	14.3	14.8
Military Bunker Fuels (-)	3.7	3.6	3.2	3.0	2.6	2.4	2.4	2.6	2.7	2.7	2.1	2.2
International Bunker Fuels (-) ..	27.3	29.1	26.7	24.2	24.1	25.1	25.4	27.3	28.6	26.6	25.5	24.2
Total Energy Adjustments ..	-22.6	-23.0	-20.2	-16.3	-15.8	-16.1	-17.6	-19.0	-18.3	-15.6	-13.4	-11.7
Adjusted Energy Total	1,337.0	1,324.8	1,352.5	1,381.0	1,402.9	1,417.9	1,467.5	1,485.3	1,494.0	1,514.5	1,564.9	1,547.0
Other Sources												
Gas Flaring	2.5	2.8	2.8	3.7	3.8	4.7	4.5	4.2	1.7	1.8	1.7	1.7
CO ₂ in Natural Gas	3.8	4.0	4.2	4.4	4.6	4.6	4.8	4.9	4.9	4.8	4.9	5.0
Cement Production	9.1	8.9	8.9	9.5	10.0	10.1	10.1	10.5	10.7	10.9	11.3	11.4
Other Industrial	7.3	7.2	7.2	7.1	7.2	7.6	7.9	8.0	8.1	8.0	8.0	7.4
Waste Combustion	4.8	5.3	5.4	5.7	6.0	6.3	6.5	7.0	6.9	7.1	6.1	6.1
Total Other Sources	27.4	28.0	28.5	30.5	31.7	33.2	33.8	34.6	32.3	32.6	32.0	31.7
Total	1,364.4	1,352.9	1,381.1	1,411.5	1,434.6	1,451.2	1,501.4	1,519.9	1,526.3	1,547.1	1,596.8	1,578.7

P = preliminary data.

Notes: Data in this table are revised from the data contained in the previous EIA report, *Emissions of Greenhouse Gases in the United States 2000*, DOE/EIA-0573(2000) (Washington, DC, November 2001). Energy-related carbon dioxide emissions have been revised as part of an agency-wide adjustment to energy consumption data and sectoral allocations. Totals may not equal sum of components due to independent rounding. Adjusted energy total includes U.S. Territories.

Sources: EIA estimates presented in this chapter.

Table 5. U.S. Carbon Dioxide Emissions from Energy Consumption by End-Use Sector, 1990-2001
(Million Metric Tons Carbon Equivalent)

End-Use Sector	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	P2001
Residential	257.5	263.0	263.0	279.6	277.2	280.1	297.0	295.0	297.6	302.5	318.1	314.9
Commercial	212.6	213.2	213.4	220.0	223.4	228.5	237.4	249.3	253.9	258.0	274.4	279.7
Industrial	458.0	447.6	465.6	461.7	469.2	468.0	482.2	486.9	479.5	474.2	478.4	452.4
Transportation	431.4	424.1	430.8	436.1	448.9	457.4	468.5	473.2	481.3	495.3	507.3	511.6
Total	1,359.5	1,347.8	1,372.8	1,397.3	1,418.7	1,434.1	1,485.2	1,504.3	1,512.3	1,530.1	1,578.3	1,558.7
Electric Power	492.3	492.2	495.7	515.9	522.5	526.8	546.5	564.8	589.2	592.8	621.2	611.7

P = preliminary data.

Notes: Data in this table are revised from the data contained in the previous EIA report, *Emissions of Greenhouse Gases in the United States 2000*, DOE/EIA-0573(2000) (Washington, DC, November 2001). Energy-related carbon dioxide emissions have been revised as part of an agency-wide adjustment to energy consumption data and sectoral allocations. Totals may not equal sum of components due to independent rounding. Electric power sector emissions are distributed across the end-use sectors. Emissions allocated to sectors are unadjusted. Adjustments are made to total emissions only (Table 4).

Sources: EIA estimates presented in this chapter.

Table 6. U.S. Carbon Dioxide Emissions from Residential Sector Energy Consumption, 1990-2001
(Million Metric Tons Carbon Equivalent)

Fuel	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	P2001
Petroleum												
Liquefied Petroleum Gas	6.3	6.7	6.6	6.8	6.8	6.9	8.1	7.9	7.4	9.1	9.3	8.5
Distillate Fuel	16.5	16.4	17.1	18.0	17.2	17.3	18.3	17.7	15.4	15.9	16.2	16.6
Kerosene	1.2	1.4	1.3	1.5	1.3	1.5	1.7	1.8	2.1	2.2	2.0	2.2
Petroleum Subtotal	24.0	24.5	24.9	26.3	25.3	25.7	28.1	27.4	24.9	27.2	27.5	27.2
Coal	0.7	0.6	0.6	0.6	0.5	0.4	0.4	0.4	0.3	0.4	0.3	0.3
Natural Gas	65.1	67.6	69.6	73.4	71.8	71.7	77.5	73.7	67.2	69.9	73.7	71.1
Electricity ^a	167.7	170.3	167.9	179.3	179.6	182.3	191.0	193.5	205.1	204.9	216.5	216.3
Total	257.5	263.0	263.0	279.6	277.2	280.1	297.0	295.0	297.6	302.5	318.1	314.9

^aShare of total electric power sector carbon dioxide emissions weighted by sales to the residential sector.

P = preliminary data.

Notes: Data in this table are revised from the data contained in the previous EIA report, *Emissions of Greenhouse Gases in the United States 2000*, DOE/EIA-0573(2000) (Washington, DC, November 2001). Energy-related carbon dioxide emissions have been revised as part of an agency-wide adjustment to energy consumption data and sectoral allocations. Totals may not equal sum of components due to independent rounding.

Sources: EIA estimates presented in this chapter.

Table 7. U.S. Carbon Dioxide Emissions from Commercial Sector Energy Consumption, 1990-2001
(Million Metric Tons Carbon Equivalent)

Fuel	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	P2001
Petroleum												
Motor Gasoline	2.1	1.6	1.5	0.6	0.5	0.3	0.5	0.8	0.8	0.9	0.9	0.9
Liquefied Petroleum Gas	1.1	1.2	1.2	1.2	1.2	1.2	1.4	1.4	1.3	1.6	1.6	1.5
Distillate Fuel	9.6	9.5	9.1	9.1	9.1	9.0	9.4	8.8	8.3	8.2	9.1	9.3
Residual Fuel	5.1	4.5	4.0	3.7	3.7	3.0	2.9	2.4	1.8	1.6	1.9	1.8
Kerosene	0.2	0.2	0.2	0.3	0.4	0.4	0.4	0.5	0.6	0.5	0.5	0.5
Petroleum Subtotal	18.2	17.1	16.1	14.9	14.8	14.0	14.6	13.8	12.9	12.8	14.0	14.0
Coal	3.3	3.1	3.1	3.1	3.1	3.0	3.1	3.3	2.4	2.7	2.3	2.3
Natural Gas	38.9	40.5	41.6	42.4	42.9	44.8	46.7	47.5	44.6	45.1	47.5	48.0
Electricity ^a	152.2	152.5	152.6	159.7	162.6	166.6	172.9	184.6	194.1	197.6	210.5	215.4
Total	212.6	213.2	213.4	220.0	223.4	228.5	237.4	249.3	253.9	258.0	274.4	279.7

^aShare of total electric power sector carbon dioxide emissions weighted by sales to the commercial sector.

P = preliminary data.

Notes: Data in this table are revised from the data contained in the previous EIA report, *Emissions of Greenhouse Gases in the United States 2000*, DOE/EIA-0573(2000) (Washington, DC, November 2001). Energy-related carbon dioxide emissions have been revised as part of an agency-wide adjustment to energy consumption data and sectoral allocations. Totals may not equal sum of components due to independent rounding.

Sources: EIA estimates presented in this chapter.

Carbon Dioxide Emissions

Table 8. U.S. Carbon Dioxide Emissions from Industrial Sector Energy Consumption, 1990-2001
(Million Metric Tons Carbon Equivalent)

Fuel	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	P2001
Petroleum												
Motor Gasoline	3.6	3.7	3.7	3.5	3.7	3.8	3.8	4.1	3.8	2.9	2.9	3.0
Liquefied Petroleum Gas	12.0	12.1	12.7	12.1	12.9	12.7	13.0	13.5	13.0	13.7	13.7	12.5
Distillate Fuel	23.2	22.4	22.5	21.6	21.7	21.0	22.1	22.2	21.9	21.1	22.3	22.8
Residual Fuel	8.2	6.4	7.6	8.9	8.4	6.6	6.6	5.6	4.3	3.8	4.5	4.2
Asphalt and Road Oil	*	*	*	*	*	*	*	*	*	*	*	*
Lubricants	1.9	1.7	1.7	1.7	1.8	1.8	1.7	1.8	1.9	1.9	1.9	1.7
Kerosene	0.2	0.2	0.2	0.3	0.3	0.3	0.4	0.4	0.4	0.3	0.2	0.2
Other Petroleum	51.4	48.3	55.1	48.9	51.5	48.6	54.4	55.5	53.5	55.8	50.4	53.4
Petroleum Subtotal	100.5	94.9	103.5	97.0	100.4	94.9	102.0	103.0	98.9	99.5	96.0	97.9
Coal	67.8	63.9	61.2	60.8	61.2	60.8	59.3	58.3	54.5	53.3	54.0	51.0
Coal Coke Net Imports	0.1	0.3	0.9	0.7	1.5	1.5	0.9	1.4	2.0	1.8	2.0	1.1
Natural Gas	118.1	119.9	125.4	127.1	126.7	133.8	138.3	138.4	135.0	130.3	133.2	123.4
Electricity^a	171.6	168.7	174.5	176.2	179.5	177.1	181.8	185.8	189.1	189.4	193.2	179.0
Total	458.0	447.6	465.6	461.7	469.2	468.0	482.2	486.9	479.5	474.2	478.4	452.4

*Less than 50,000 metric tons carbon equivalent.

^aShare of total electric power sector carbon dioxide emissions weighted by sales to the industrial sector.

P = preliminary data.

Notes: Data in this table are revised from the data contained in the previous EIA report, *Emissions of Greenhouse Gases in the United States 2000*, DOE/EIA-0573(2000) (Washington, DC, November 2001). Energy-related carbon dioxide emissions have been revised as part of an agency-wide adjustment to energy consumption data and sectoral allocations. Totals may not equal sum of components due to independent rounding.

Sources: EIA estimates presented in this chapter.

Table 9. U.S. Carbon Dioxide Emissions from Transportation Sector Energy Consumption, 1990-2001
(Million Metric Tons Carbon Equivalent)

Fuel	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	P2001
Petroleum												
Motor Gasoline	260.5	259.2	263.0	268.9	273.3	279.0	284.0	286.5	292.5	299.7	301.5	308.0
Liquefied Petroleum Gas	0.4	0.3	0.3	0.3	0.6	0.3	0.3	0.2	0.3	0.2	0.2	0.2
Jet Fuel	60.1	58.1	57.6	58.1	60.4	60.0	62.7	63.3	64.2	66.3	68.5	65.6
Distillate Fuel	75.6	72.6	75.2	77.2	82.3	85.1	89.7	93.4	97.0	101.9	105.0	107.5
Residual Fuel	21.6	21.8	22.8	19.2	18.8	19.4	18.1	15.1	14.3	14.2	18.9	17.8
Lubricants	1.8	1.6	1.6	1.6	1.7	1.7	1.6	1.7	1.8	1.8	1.8	1.6
Aviation Gasoline	0.8	0.8	0.8	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7
Petroleum Subtotal	420.9	414.4	421.3	426.1	437.8	446.1	457.1	461.1	470.8	484.7	496.7	501.4
Coal	*	*	*	*	*	*	*	*	*	*	*	*
Natural Gas	9.8	8.9	8.8	9.3	10.2	10.4	10.6	11.2	9.6	9.7	9.7	9.2
Electricity^a	0.7	0.7	0.7	0.7	0.9	0.9	0.9	0.9	0.9	0.9	1.0	1.0
Total	431.4	424.1	430.8	436.1	448.9	457.4	468.5	473.2	481.3	495.3	507.3	511.6

*Less than 50,000 metric tons carbon equivalent.

^aShare of total electric power sector carbon dioxide emissions weighted by sales to the transportation sector.

P = preliminary data.

Notes: Data in this table are revised from the data contained in the previous EIA report, *Emissions of Greenhouse Gases in the United States 2000*, DOE/EIA-0573(2000) (Washington, DC, November 2001). Energy-related carbon dioxide emissions have been revised as part of an agency-wide adjustment to energy consumption data and sectoral allocations. Totals may not equal sum of components due to independent rounding.

Sources: EIA estimates presented in this chapter.

Table 10. U.S. Carbon Dioxide Emissions from Electric Power Sector Energy Consumption, 1990-2001
(Million Metric Tons Carbon Equivalent)

Generator Type and Fuel	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	P2001
Total Emissions from Fuel Use												
Petroleum												
Heavy Fuel Oil	24.3	22.9	18.4	20.2	18.3	11.9	13.2	15.1	22.1	20.2	18.4	20.9
Light Fuel Oil	1.9	1.7	1.5	1.7	2.4	2.1	2.2	2.2	2.7	2.8	3.5	3.5
Petroleum Coke	0.8	0.8	1.2	2.2	1.9	2.2	2.2	2.8	3.4	3.1	2.7	3.0
Petroleum Subtotal	27.0	25.3	21.1	24.1	22.6	16.3	17.6	20.0	28.2	26.1	24.5	27.5
Coal	417.3	417.8	423.7	440.4	442.2	448.2	472.9	484.9	493.3	495.7	520.1	506.4
Natural Gas	47.8	48.9	50.9	51.3	57.6	62.3	55.9	59.7	67.6	70.9	76.5	77.7
Geothermal	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Total	492.3	492.2	495.7	515.9	522.5	526.8	546.5	564.8	589.2	592.8	621.2	611.7
Emissions from Fuel Use for Electricity Generation												
Petroleum												
Heavy Fuel Oil	24.1	22.7	18.2	20.1	18.2	11.8	13.1	14.9	22.0	20.1	18.3	20.8
Light Fuel Oil	1.9	1.6	1.4	1.7	2.3	2.1	2.1	2.1	2.7	2.7	3.4	3.5
Petroleum Coke	0.8	0.8	1.2	2.1	1.9	2.0	2.0	2.7	3.3	3.0	2.6	2.9
Petroleum Subtotal	26.8	25.2	20.9	23.9	22.4	15.9	17.3	19.7	28.0	25.9	24.3	27.2
Coal	416.8	417.1	422.8	439.5	441.1	446.9	471.6	483.7	492.0	494.1	518.4	504.7
Natural Gas	46.4	47.5	49.1	49.4	55.5	60.2	53.7	57.3	65.1	68.3	73.7	74.4
Geothermal	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Total	490.1	489.9	492.9	512.8	519.0	523.1	542.7	560.8	585.1	588.4	616.6	606.5
Emissions from Fuel Use for Thermal Energy Production												
Petroleum												
Heavy Fuel Oil	0.2	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.1	0.1	0.1	*
Light Fuel Oil	*	*	*	*	*	0.1	*	*	*	*	*	0.1
Petroleum Coke	0.0	0.0	*	*	*	0.2	0.1	0.1	0.1	0.1	0.1	0.1
Petroleum Subtotal	0.2	0.1	0.2	0.2	0.2	0.4	0.3	0.3	0.2	0.2	0.2	0.2
Coal	0.5	0.7	0.9	1.0	1.2	1.3	1.3	1.2	1.3	1.6	1.6	1.7
Natural Gas	1.4	1.5	1.8	1.9	2.1	2.1	2.2	2.4	2.5	2.6	2.8	3.3
Total	2.1	2.3	2.9	3.1	3.5	3.7	3.8	4.0	4.0	4.4	4.7	5.2

*Less than 50,000 metric tons carbon equivalent. P = preliminary data.

Notes: Data in this table are revised from the data contained in the previous EIA report, *Emissions of Greenhouse Gases in the United States 2000*, DOE/EIA-0573(2000) (Washington, DC, November 2001). Energy-related carbon dioxide emissions have been revised as part of an agency-wide adjustment to energy consumption data and sectoral allocations. Emissions for total fuel consumption are allocated to end-use sectors in proportion to electricity sales. Totals may not equal sum of components due to independent rounding.

Sources: EIA estimates presented in this chapter.

Table 11. U.S. Carbon Sequestered by Nonfuel Use of Energy Fuels, 1990-2001
(Million Metric Tons Carbon Equivalent)

End Use and Type	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	P2001
Industrial												
Petroleum												
Liquefied Petroleum Gases. . .	16.2	18.6	18.7	18.2	20.9	21.4	22.3	22.6	21.6	24.4	25.1	22.8
Distillate Fuel	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Residual Fuel	0.5	0.7	0.6	0.6	0.5	0.6	0.6	0.6	0.6	0.6	0.6	0.6
Asphalt and Road Oil	24.1	22.2	22.7	23.7	24.2	24.3	24.2	25.2	26.0	27.3	26.3	25.9
Lubricants	1.9	1.7	1.7	1.8	1.8	1.8	1.7	1.8	1.9	2.0	1.9	1.8
Other (Subtotal)	19.7	19.2	20.3	22.0	22.7	22.7	23.2	24.7	26.2	26.9	25.3	23.0
Pentanes Plus.	1.2	0.7	0.9	4.0	3.8	4.4	4.6	4.4	3.9	4.8	4.6	3.5
Petrochemical Feed	12.6	12.6	13.4	13.6	14.1	13.6	13.8	15.9	16.1	15.1	15.7	13.8
Petroleum Coke	2.5	2.1	3.2	1.7	1.9	1.8	2.1	1.6	3.0	4.0	2.0	2.5
Waxes and Miscellaneous ..	3.4	3.7	2.7	2.7	2.9	2.7	2.7	2.8	3.2	3.0	3.0	3.2
Coal	0.4	0.4	0.8	0.6	0.5	0.6	0.6	0.5	0.5	0.5	0.5	0.5
Natural Gas	4.1	3.9	3.5	3.9	5.0	4.7	4.7	5.1	6.0	5.0	5.1	4.6
Transportation												
Lubricants	1.8	1.6	1.6	1.7	1.7	1.7	1.6	1.7	1.8	1.8	1.8	1.7
Total	68.7	68.2	70.0	72.4	77.5	77.8	79.1	82.4	84.8	88.7	86.7	81.0

P = preliminary data.

Notes: Data in this table are revised from the data contained in the previous EIA report, *Emissions of Greenhouse Gases in the United States 2000*, DOE/EIA-0573(2000) (Washington, DC, November 2001). Totals may not equal sum of components due to independent rounding.

Sources: EIA estimates presented in this chapter.

Carbon Dioxide Emissions

Table 12. U.S. Carbon Dioxide Emissions from Industrial Processes, 1990-2001
(Million Metric Tons Carbon Equivalent)

Source	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	P2001
Cement Manufacture												
Clinker Production	8.90	8.66	8.75	9.25	9.82	9.85	9.91	10.24	10.48	10.69	11.01	11.12
Masonry Cement	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.03	0.03	0.03	0.03
Cement Kiln Dust	0.18	0.17	0.18	0.19	0.20	0.20	0.20	0.20	0.21	0.21	0.22	0.22
Cement Subtotal	9.09	8.85	8.94	9.46	10.04	10.07	10.13	10.47	10.72	10.93	11.26	11.37
Other Industrial												
Limestone Consumption												
Lime Manufacture	3.39	3.36	3.47	3.58	3.73	3.96	4.11	4.22	4.30	4.22	4.20	4.00
Iron Smelting	0.47	0.44	0.37	0.31	0.30	0.31	0.30	0.31	0.30	0.29	0.30	0.27
Steelmaking	0.08	0.09	0.07	0.13	0.15	0.14	0.11	0.09	0.10	0.07	0.12	0.17
Copper Refining	0.04	0.04	0.04	0.04	0.04	0.05	0.05	0.05	0.05	0.05	0.04	0.04
Glass Manufacture	0.03	0.03	0.04	0.05	0.08	0.09	0.05	0.02	0.05	0.05	0.05	0.05
Flue Gas Desulfurization	0.18	0.19	0.19	0.18	0.19	0.24	0.26	0.28	0.27	0.29	0.32	0.32
Dolomite Manufacture	0.13	0.10	0.08	0.07	0.07	0.06	0.09	0.09	0.09	0.04	0.09	0.09
Limestone Subtotal	4.33	4.24	4.27	4.36	4.57	4.85	4.98	5.05	5.15	5.00	5.11	4.94
Soda Ash Manufacture	0.92	0.92	0.94	0.91	0.92	1.04	1.03	1.08	1.04	1.00	0.99	0.97
Soda Ash Consumption												
Glass Manufacture	*	*	*	*	*	*	*	*	*	*	*	*
Flue Gas Desulfurization	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.03	0.03	0.02	0.03	0.03
Sodium Silicate	0.05	0.05	0.05	0.06	0.06	0.07	0.06	0.07	0.07	0.06	0.07	0.07
Sodium Tripolyphosphate	0.04	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.02	0.01	0.01	0.01
Soda Ash Subtotal	0.10	0.10	0.10	0.11	0.11	0.13	0.12	0.14	0.12	0.10	0.11	0.11
Carbon Dioxide Manufacture . .	0.24	0.25	0.26	0.26	0.27	0.29	0.30	0.31	0.32	0.34	0.35	0.37
Aluminum Manufacture	1.62	1.65	1.62	1.48	1.32	1.35	1.43	1.44	1.48	1.51	1.47	1.04
Shale Oil Production	0.05	*	*	*	*	*	*	*	*	*	*	*
Other Industrial Subtotal . . .	7.27	7.16	7.19	7.12	7.19	7.65	7.86	8.02	8.12	7.95	8.03	7.43
Total	16.36	16.02	16.14	16.58	17.23	17.72	17.99	18.49	18.84	18.88	19.29	18.79

*Less than 50,000 metric tons carbon equivalent.

P = preliminary data.

Notes: Data in this table are revised from the data contained in the previous EIA report, *Emissions of Greenhouse Gases in the United States 2000*, DOE/EIA-0573(2000) (Washington, DC, November 2001). Totals may not equal sum of components due to independent rounding.

Sources: EIA estimates presented in this chapter.